ISOLDE GUI Meeting

CERN, 6th February 2017

RILIS status and development plans for 2017

Bruce Marsh, *CERN EN-STI-LP*

Engineering Department

Outline

- Operational details - scheduling and manpower
    - summary of 2016
    - outlook for 2017
- Hardware upgrade / consolidation
- Ionization scheme development
- Ion source development possibilities, priorities and LOIs
    - High selectivity RILIS
    - High resolution RILIS

RILIS on-line operation in 2016

130 days of RILIS operation (mostly 24-hr)

22 separate RILIS runs

14 different elements

3 RILIS physics runs
(RILIS as a spectroscopy tool during ion beam production)

100 % record for on-time setup of RILIS

>75 % of ISOLDE physics

1 laser failure which required a factory repair
(it did not adversely affect operation)

RILIS team in 2016

72 person-months

Valentin Fedosseev

Section Leader
EN-STI-LP

Sebastian Rothe

Previous COFUND Fellow
Visiting Scientist
Gothenburg / Manchester

Christoph Seiffert

COFUND Fellow
CERN

Katerina Chrysalidis

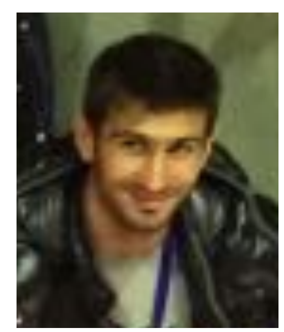
Doctoral student
(Oct 16 onwards)
Univ. Mainz

Bruce Marsh

Staff Member
EN-STI-LP

Tom Day Goodacre

MC Fellow (LA3NET)
Final year CERN PhD student
Manchester University



Pierre Larmonier

CERN VIA trainee
October onwards

Julia Sundberg

CERN PhD student
Univ. Gothenburg

+ 7.5 person-months PNPI support

RILIS team in 2017

Valentin Fedosseev

Section Leader
EN-STI-LP

Bruce Marsh

Staff Member
EN-STI-LP

Pierre Larmonier
CERN VIA trainee

Katerina Chrysalidis

Doctoral student
Univ. Mainz

We have lost 3 people with a combined RILIS experience of **14 years**

RILIS team in 2017

59 person-months

Valentin Fedosseev

Section Leader
EN-STI-LP

Bruce Marsh

Staff Member
EN-STI-LP

Student #2

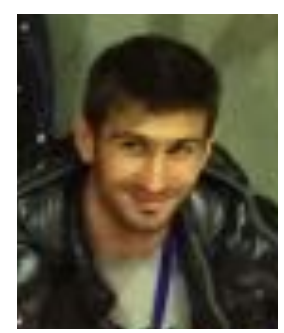
Externally funded
Mid-late summer

Camilo Buitrago

CERN Fellow
April 2017 onwards

Fellow #2

CERN Fellow
Late summer ?



Pierre Larmonier

CERN VIA trainee

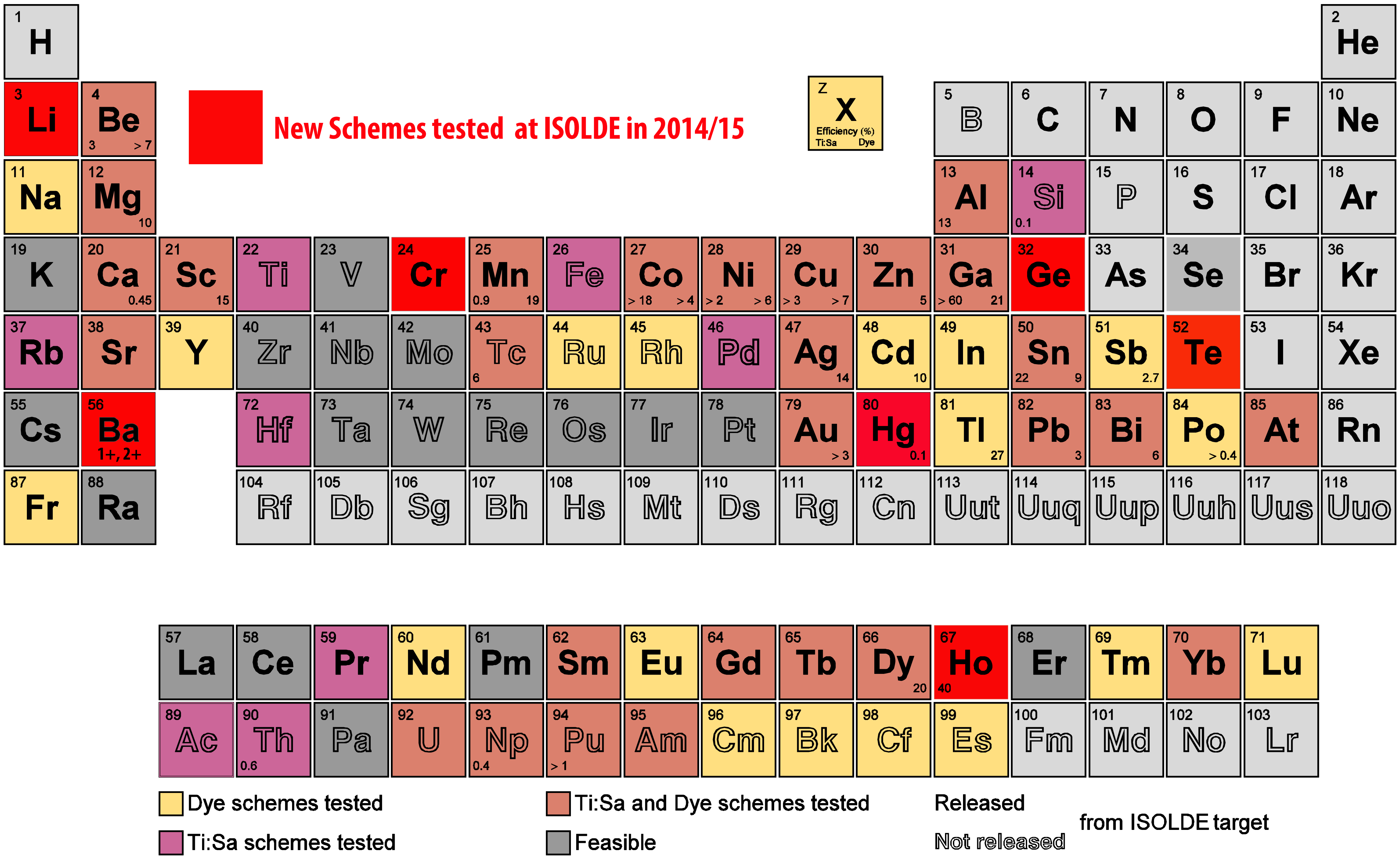
Katerina Chrysalidis

Doctoral student
Univ. Mainz

+ 8 person-months PNPI support

- Extended RILIS setup time
- Reduced on-call support (no backup)

Accessible elements



Achieved in 2016: **Eu**, **Te** efficiency, alternative **Bi** scheme, **Ra, Fe, Mo**

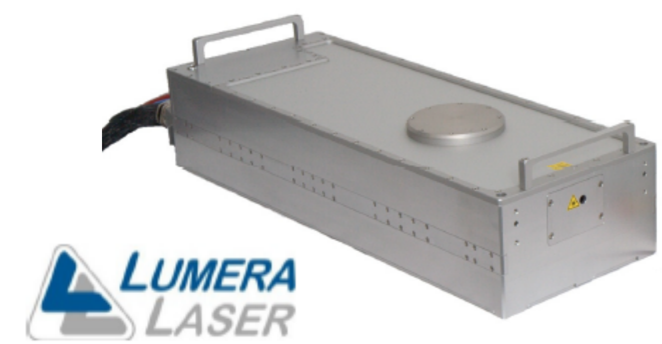
Aim for 2017: **Er, Si,** Se, **Lu,** *Zn (to improve RILIS setup)*

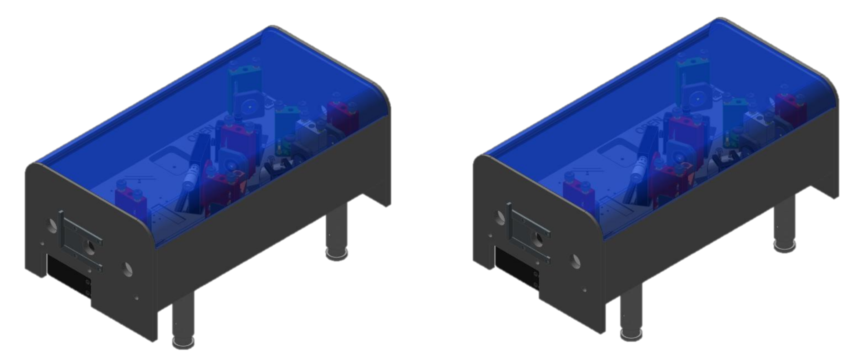
RILIS hardware consolidation and upgrades

ONLINE

Consolidation budget from EN-Dept:
280 kCHF available now

- RILIS dye pump laser replacement in 2017
- Spare BLAZE laser in 2017 (delivery March)
- 2 new TiSa cavities delivered
- Pulse amplified CW lasers for PI-LIST
- Test picosecond laser for molecular breakup





OFFLINE (+ MEDICIS)

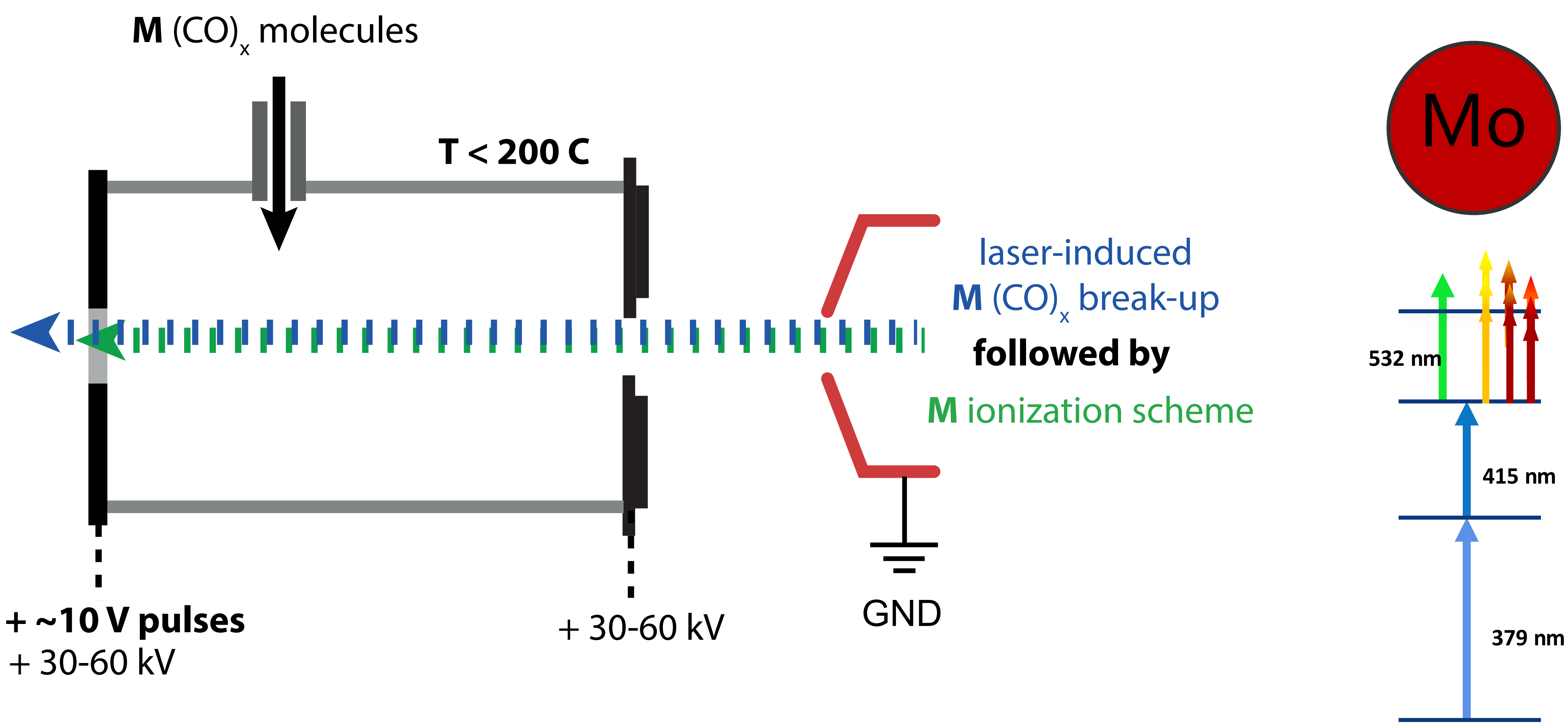
- ~275 kCHF required to equip RILIS @ offline-2
- Offline-2 can also be considered a RILIS@MEDICIS test bench

LOI 1 - Mo(CO)6 - Molecular breakup + ionisation

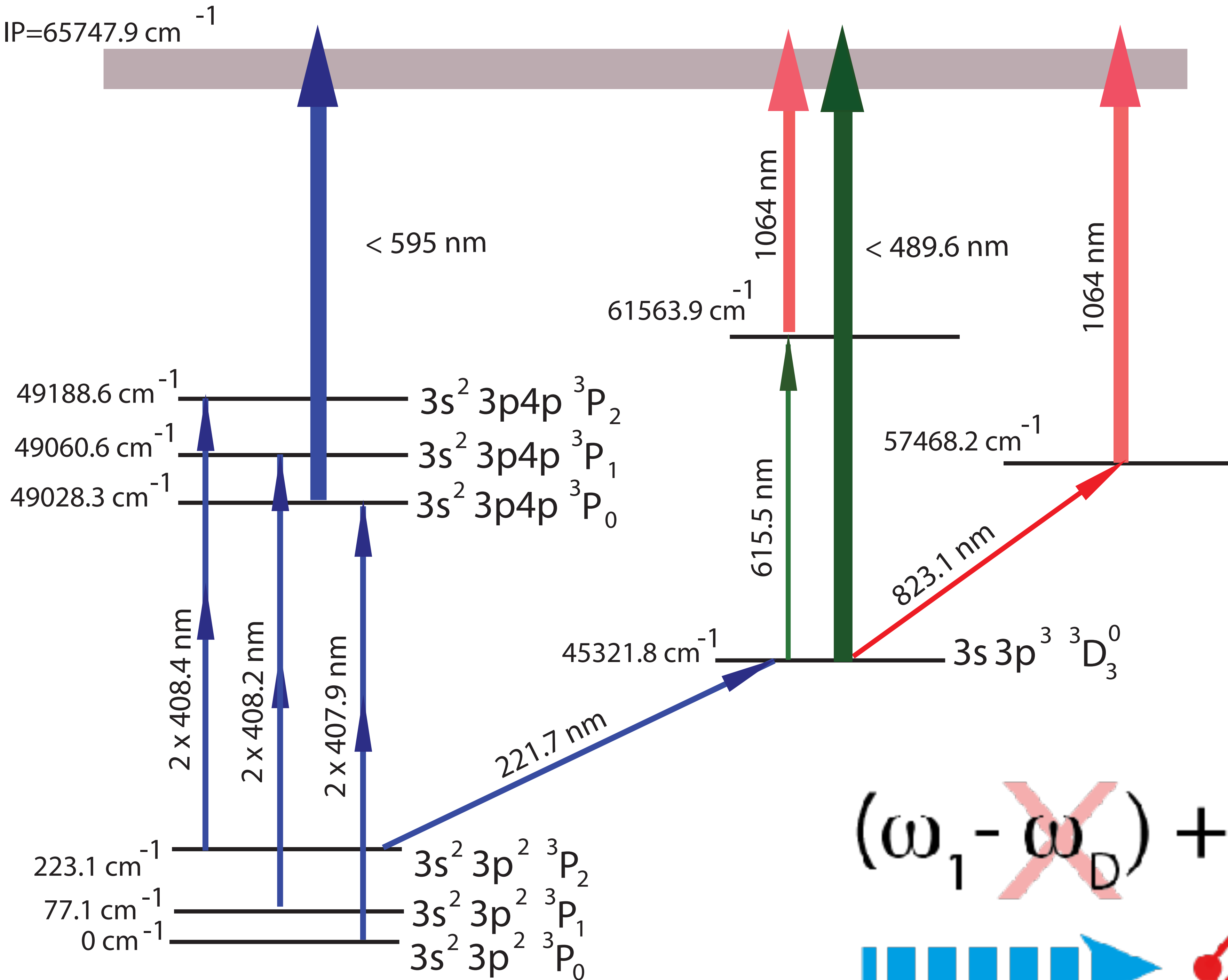
1) Creation and transport of volatile molecules of refractory metals

2) Dissociation by laser pulse

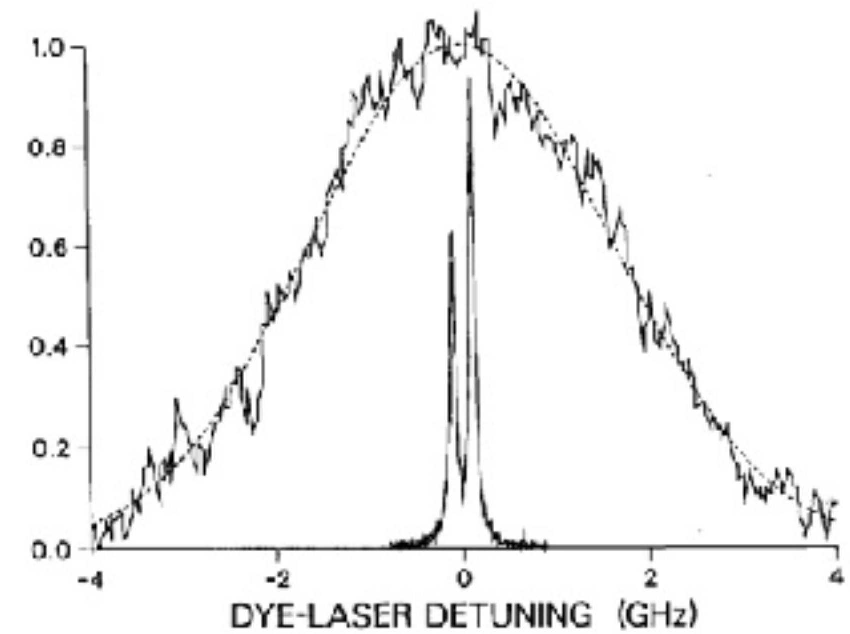
3) Resonance ionisation before atom/wall collision



LOI 2: 2-photon spectroscopy



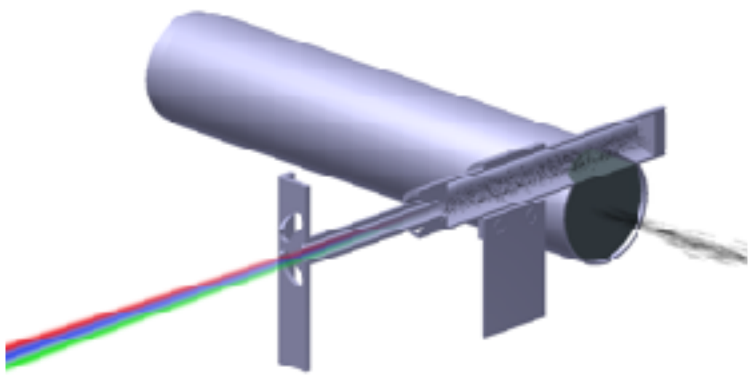
Si I

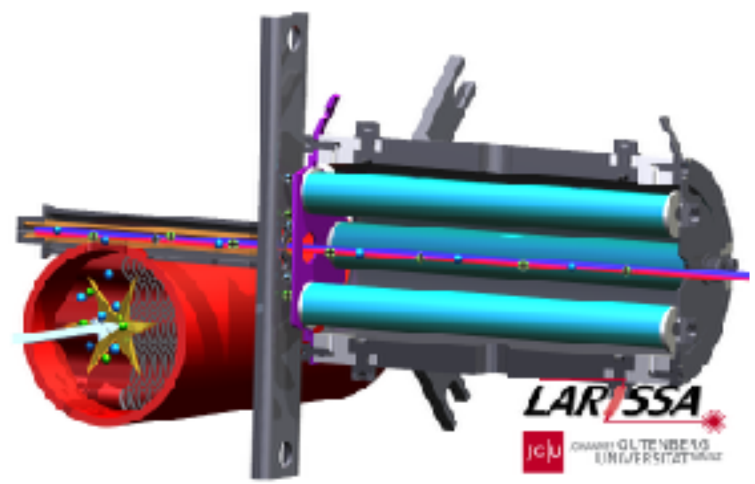


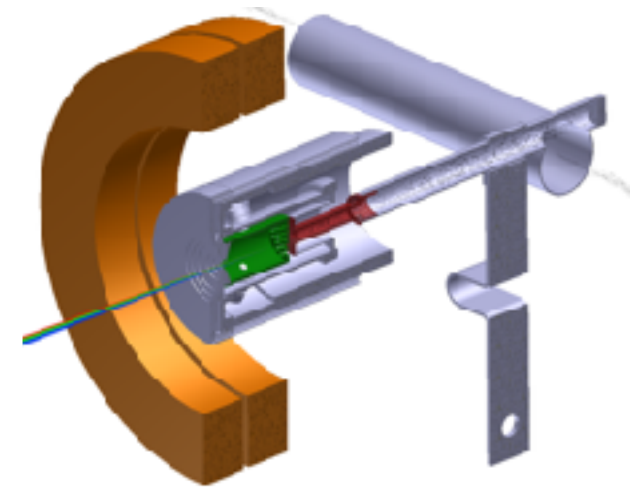
$$(\omega_1 - \omega_D) + (\omega_1 + \omega_D) = 2\omega_1$$

RILIS cavity development directions

HC-RILIS | **HC-LIST** | **VADLIS**







+ Adjustable extractor

HIGH SELECTIVITY

High resistance cavity

Pulsed line heating

ToF-LIS

Short LIST

'DC-offset' LIST mode

Inverted-LINE LIST

Inverted-LINE LIST

LWF-VADLIS

HIGH RESOLUTION

2-photon HC-RILIS

PI-LIST

2-photon VADLIS

RILIS for M(CO)x breakup + ionization

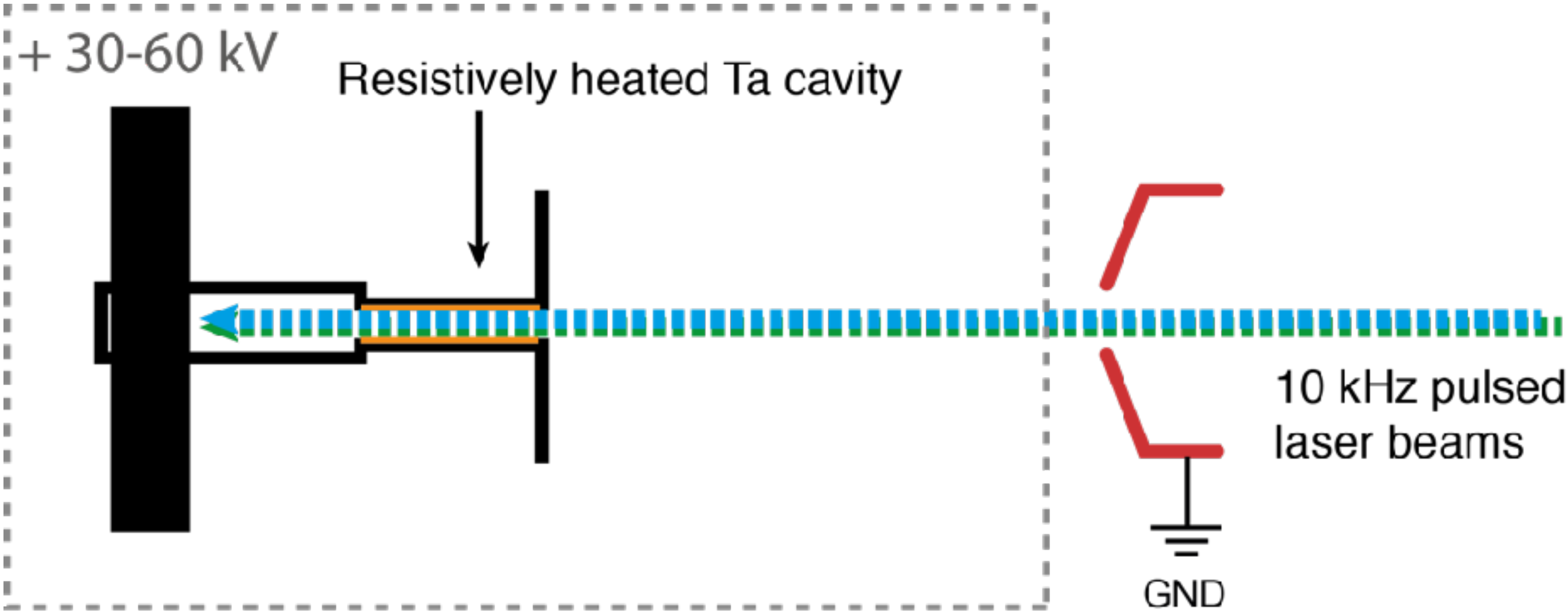
Setting development priorities

$$\frac{\text{Feasibility} \times \text{Usefulness}}{\text{Resources} \times 0.5} = ?$$

Suggestion: apply a 1-10 rating to each of these:

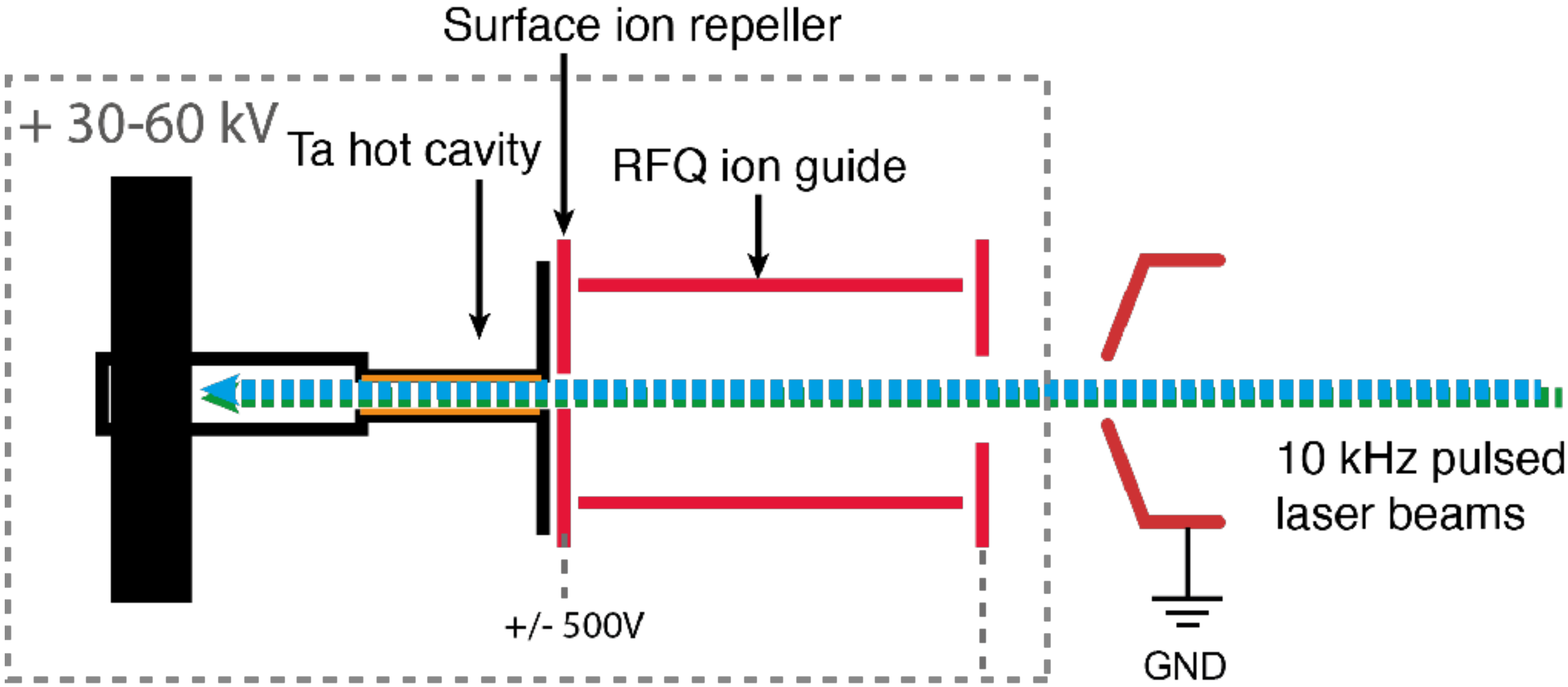
- **Feasibility** How likely it is to work as intended and withstand ISOLDE conditions?
- **Usefulness** How much benefit does it bring compared to existing options?
- **Resources** What are the financial, time, manpower and equipment costs?

Hot-Cavity RILIS



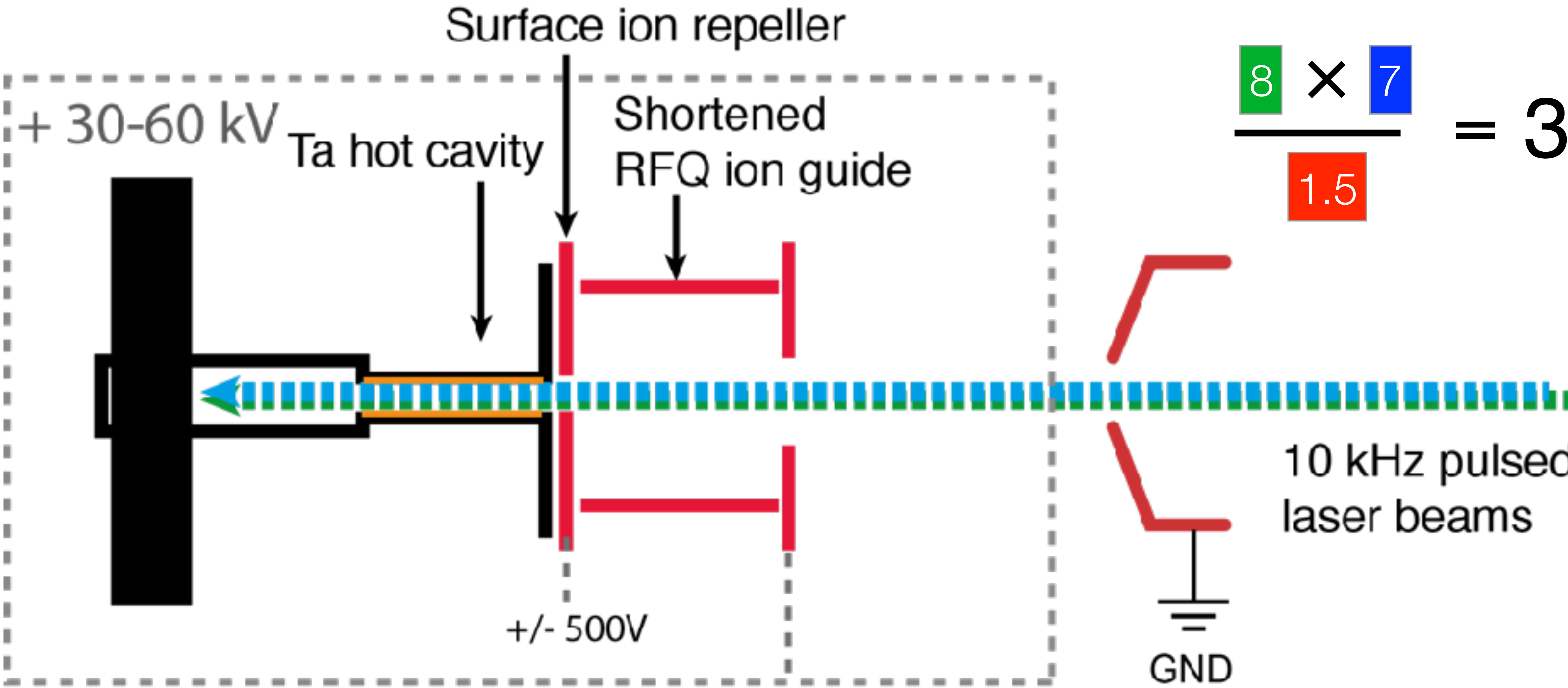
- Simple, robust, reliable
- Long standing problem with surface-ionised isobars
- Ion capacity limit in the range of 100 - 200 nA

High Selectivity RILIS — LIST



- 2-5 orders of magnitude surface ion suppression in LIST mode
- Efficiency loss factor of ~20
- Currently only compatible with GPS

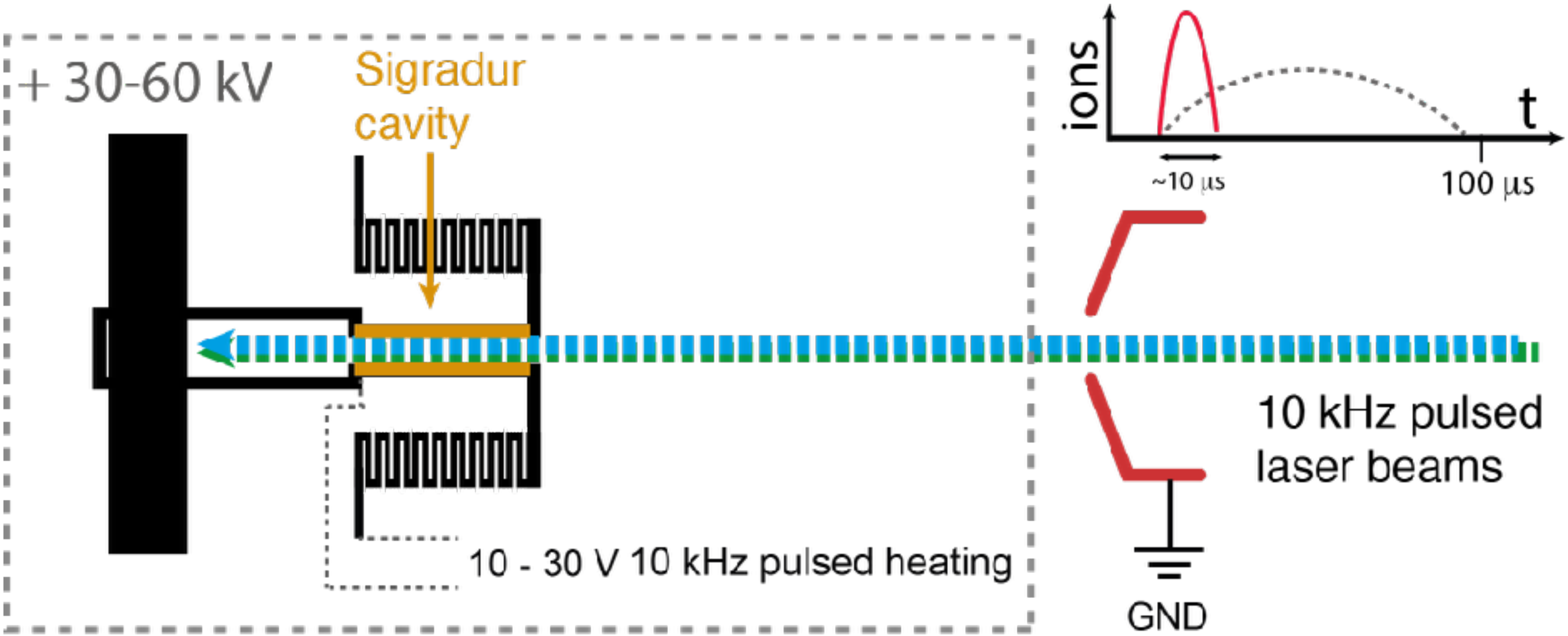
High Selectivity RILIS #1 — Short LIST



$$\frac{8 \times 7}{1.5} = 37$$

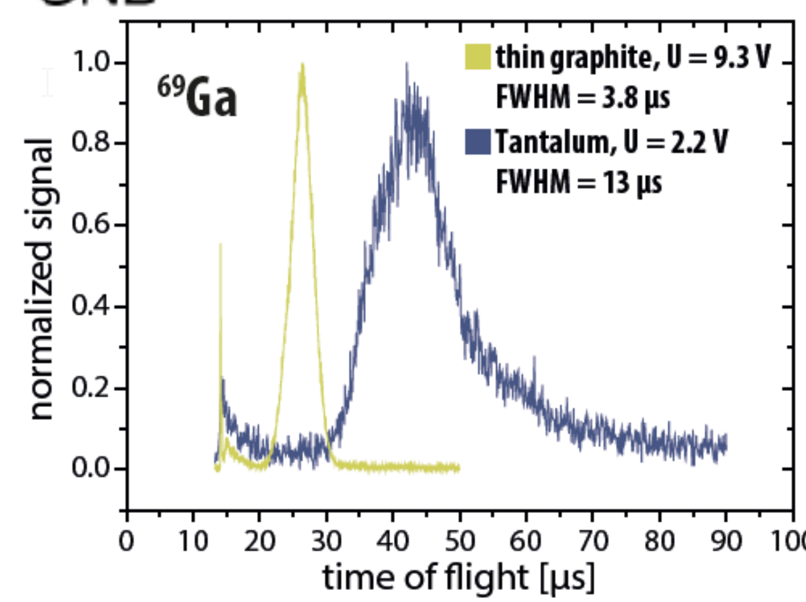
- New size enables compatibility with quartz line for extra selectivity
- No additional efficiency loss factor
- Accepted proposal for Tl, Po
- Quartz line suppression of Fr, Ra and transmission of Tl, Po unknown

High Selectivity RILIS #2 — HR Cavity

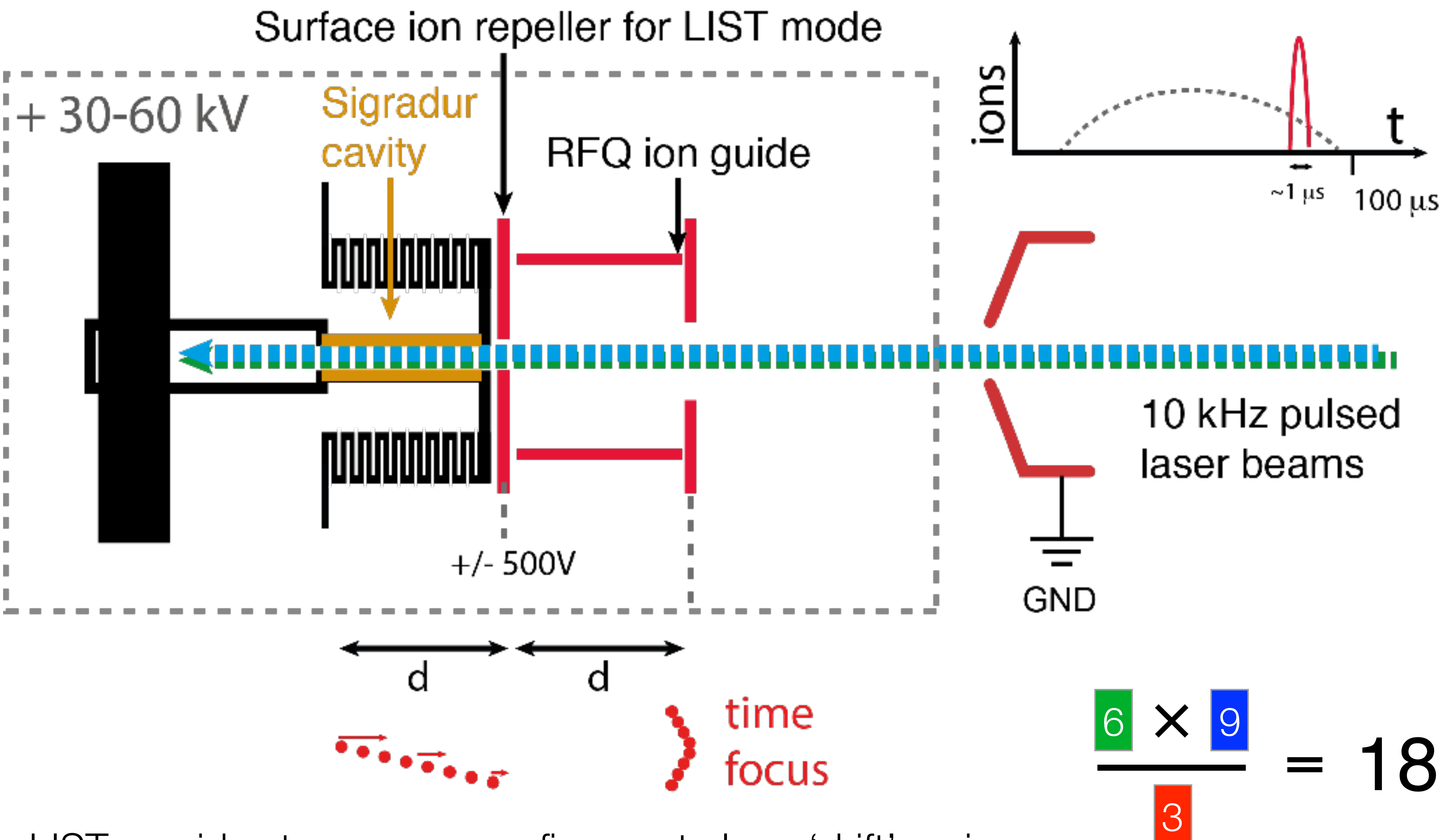


- Factor of ~10 surface ion suppression by beam gating
- Negligible efficiency loss?
- Possible improvement in hot cavity ion capacity??

$$\frac{7 \times 9}{2.5} = 25$$

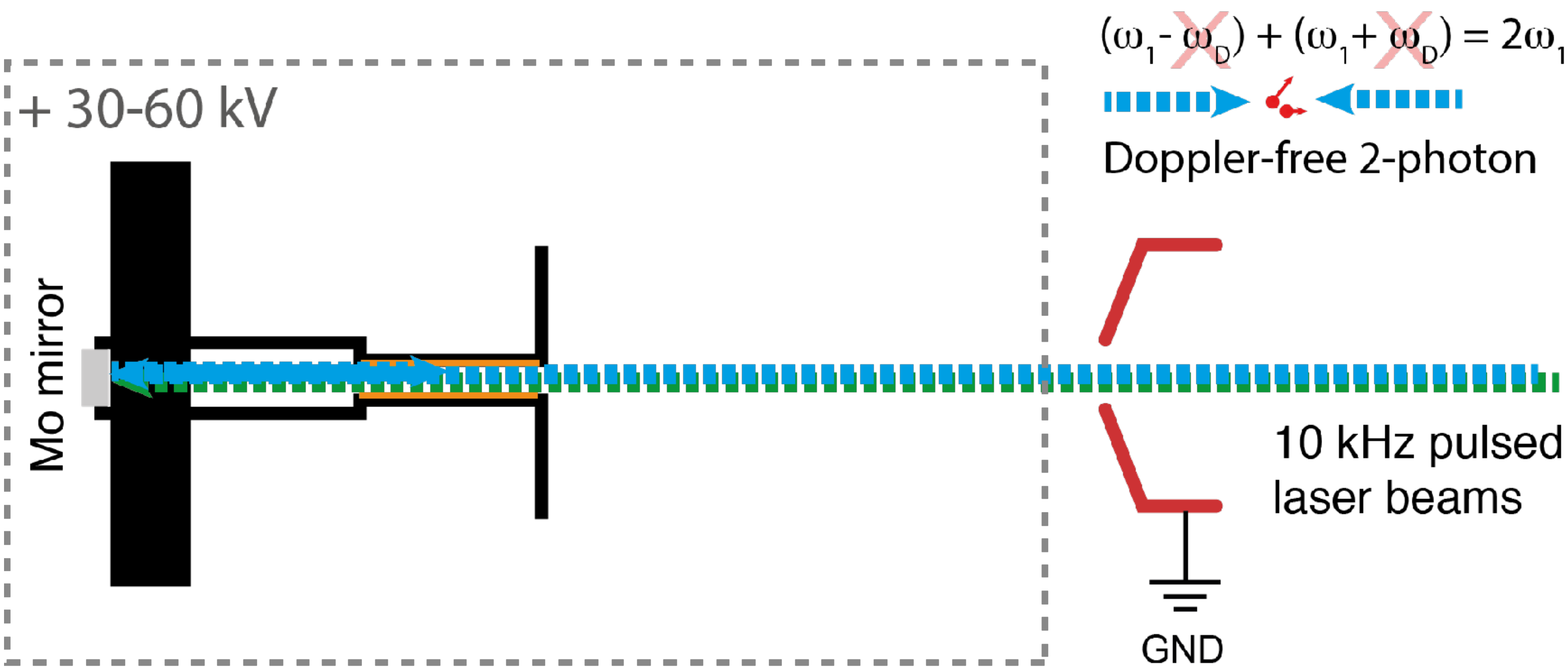


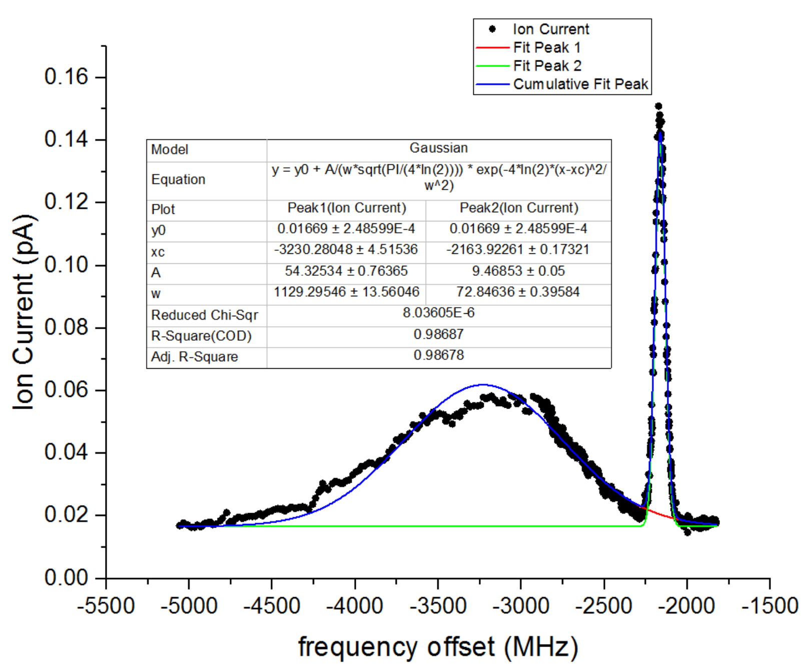
High Selectivity RILIS #3 — ToF-LIS



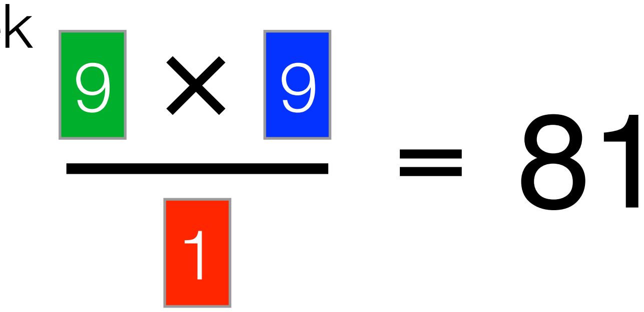
- LIST provides transverse confinement along ‘drift’ region
- Hot-cavity (ion-guide) and standard LIST mode still available

High Resolution RILIS #1 — Hot Cavity, 2P

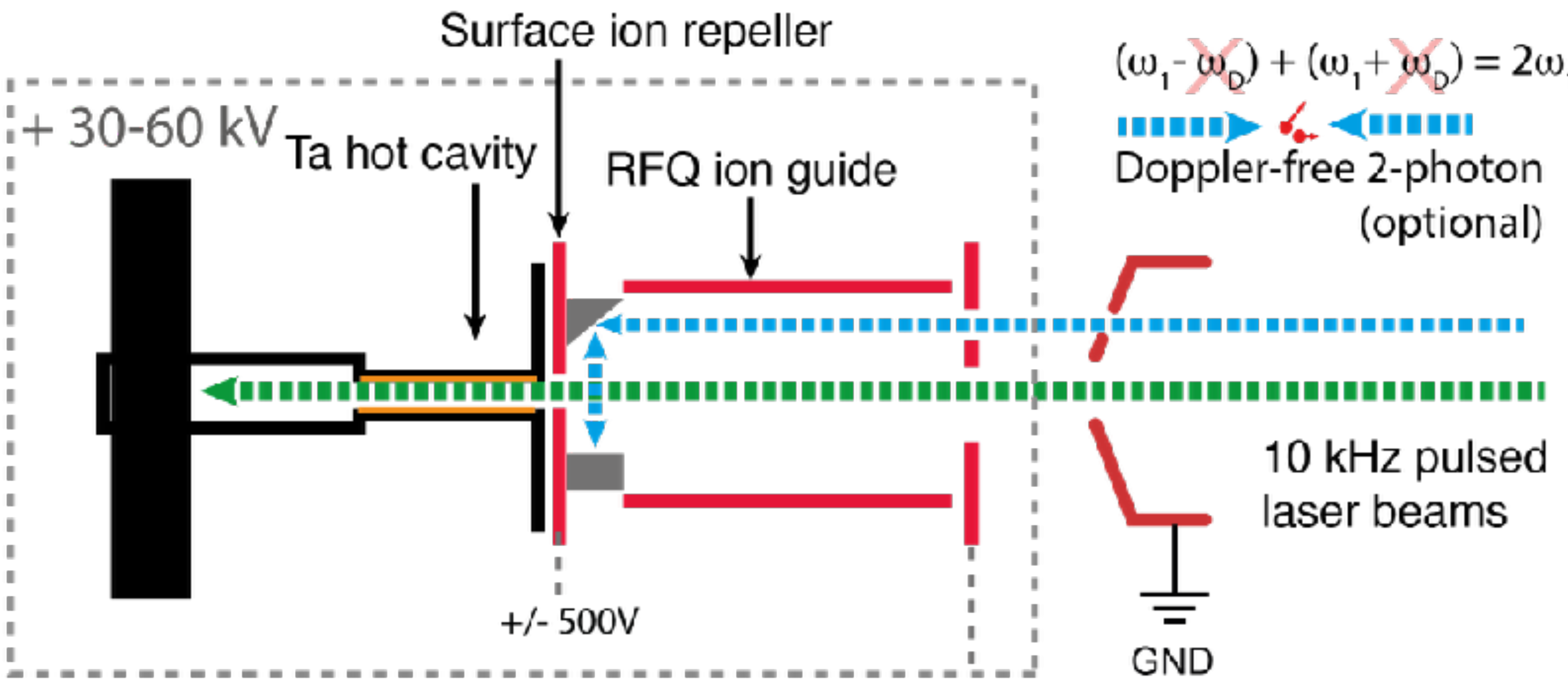


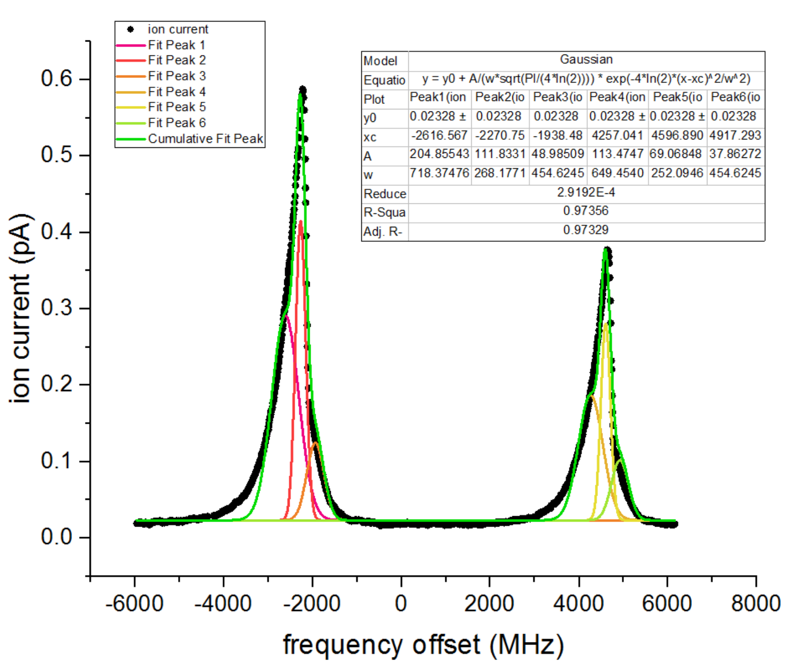


- Simple, robust, no additional cold spots
- Compatible with normal RILIS / surface ion source operation
- Requires pulsed amplified CW laser
- LOI for Si being considered this week
- Feasibility demonstrated at Mainz / LARISSA
- PhD topic of Katerina Chrysalidis



High Resolution RILIS #2 — PI-LIST



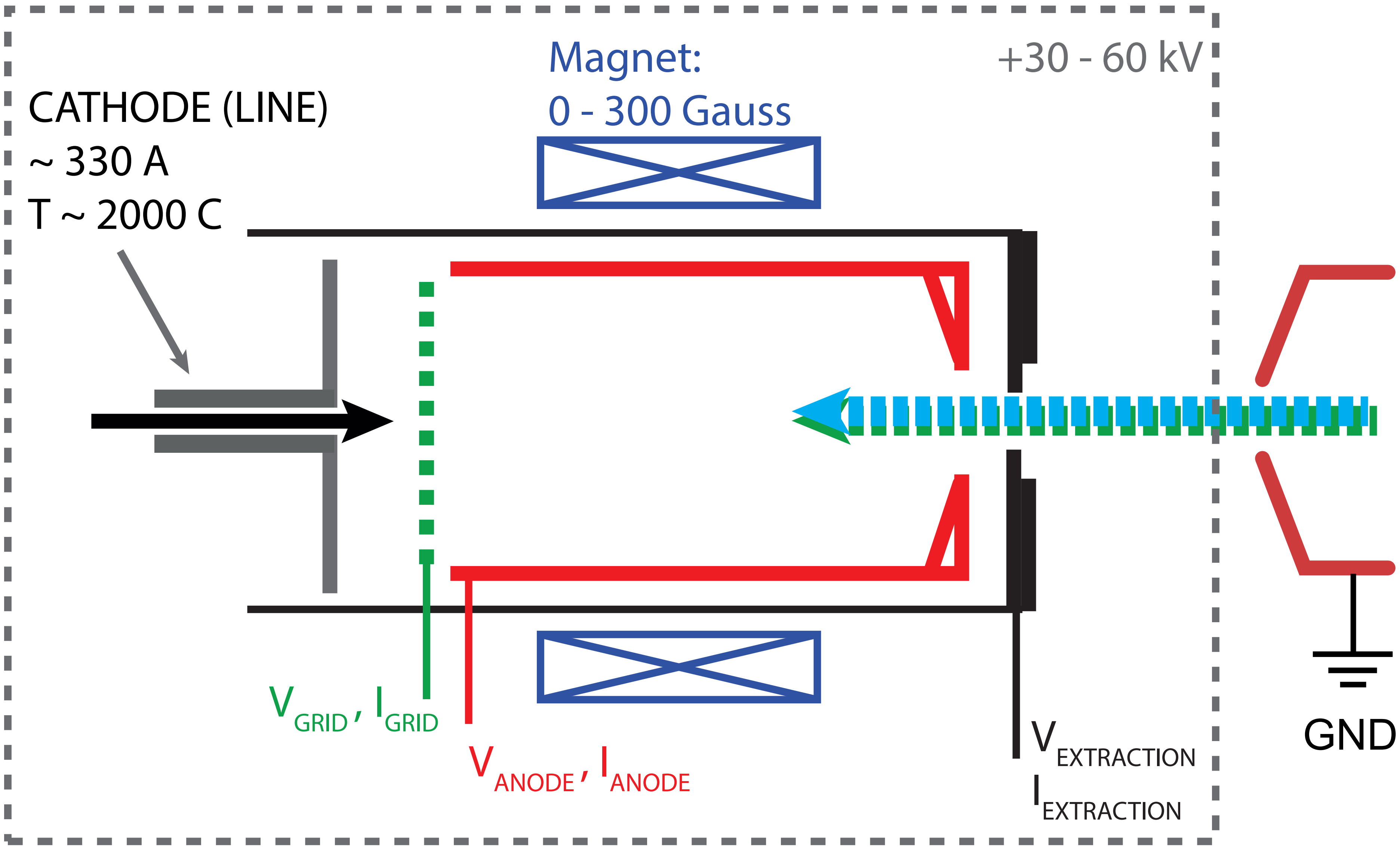


- 100-200x efficiency loss due to poor laser/atom overlap
- 3-5 orders-of-magnitude SI suppression
- ~100 MHz resolution even without Doppler-free 2 photon excitation
- Extra complexity compared to HC-RILIS only
- Requires pulsed amplified CW laser
- Feasibility demonstrated at Mainz / LARISSA
- PhD topic of Reinhard Heinke and Katerina Chrysalidis (2-photon)

$$\frac{9 \times 6}{3.5} = 15$$

Spare slides

VADLIS with adjustable extraction voltage

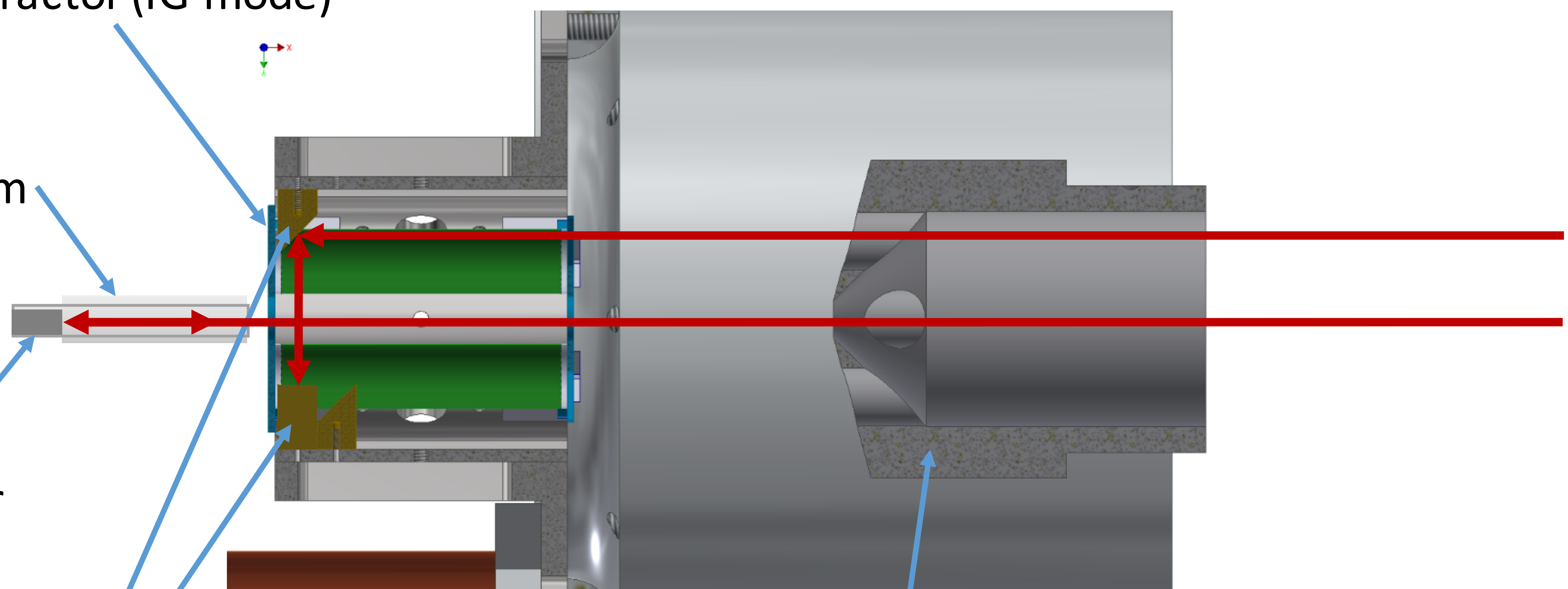


Somewhat decouple electron current, energy and ion extraction : more knobs to turn

Maintain extraction potential during RILIS-Mode operation: $V_{EXTRACTION}$ = -100 V

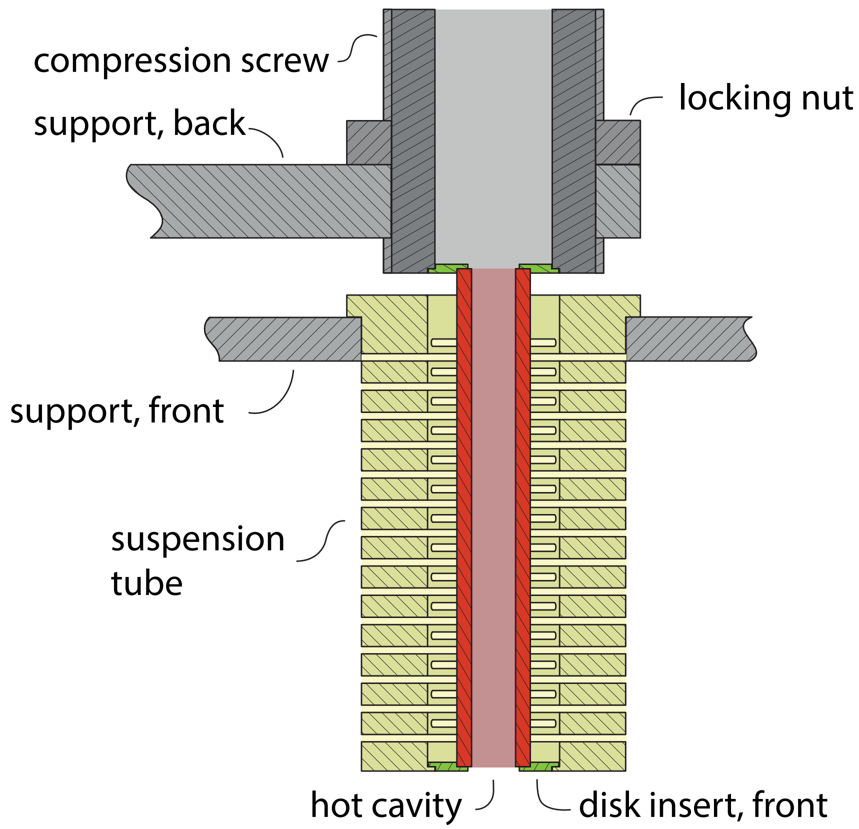
Improved ion source diagnostics : separate current measurements for each component

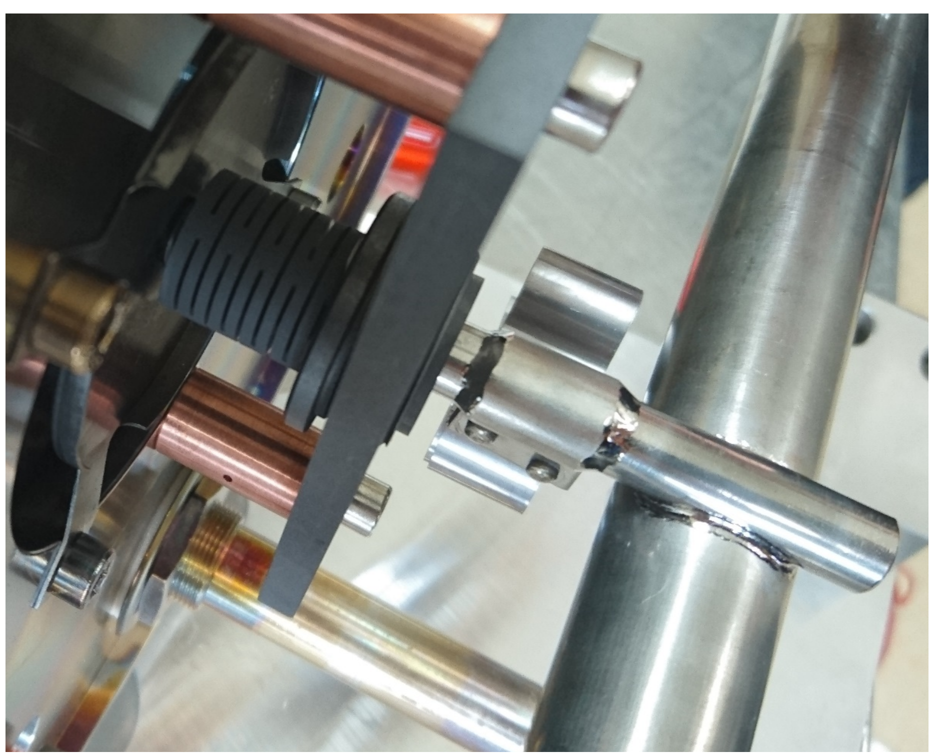
2-photon spectroscopy @ LARISSA



JG|U LARISSA
JOHANNES GUTENBERG-UNIVERSITÄT MAINZ

Sigradur — a RECAP



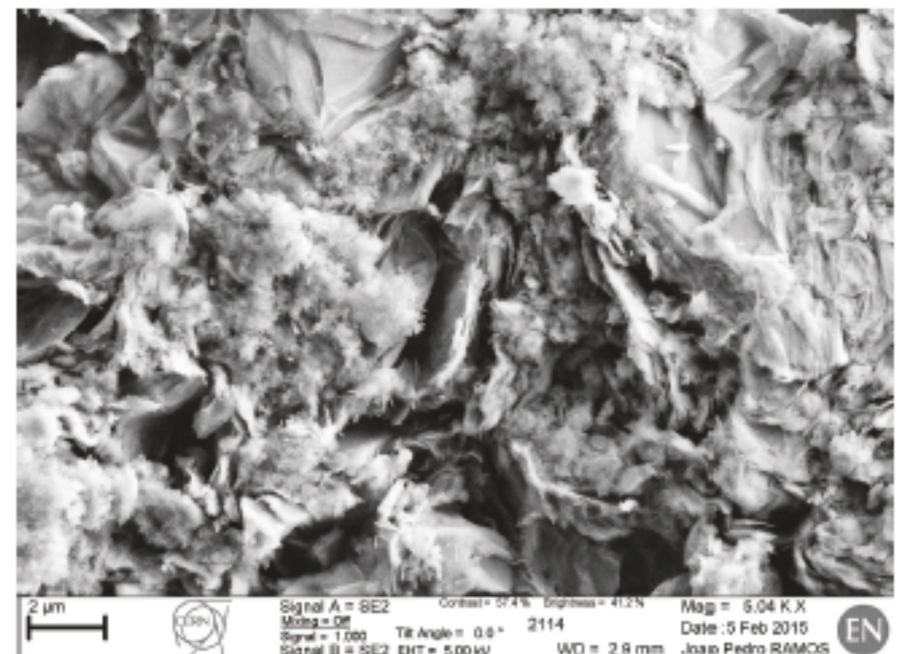


SEM surface analysis

Li

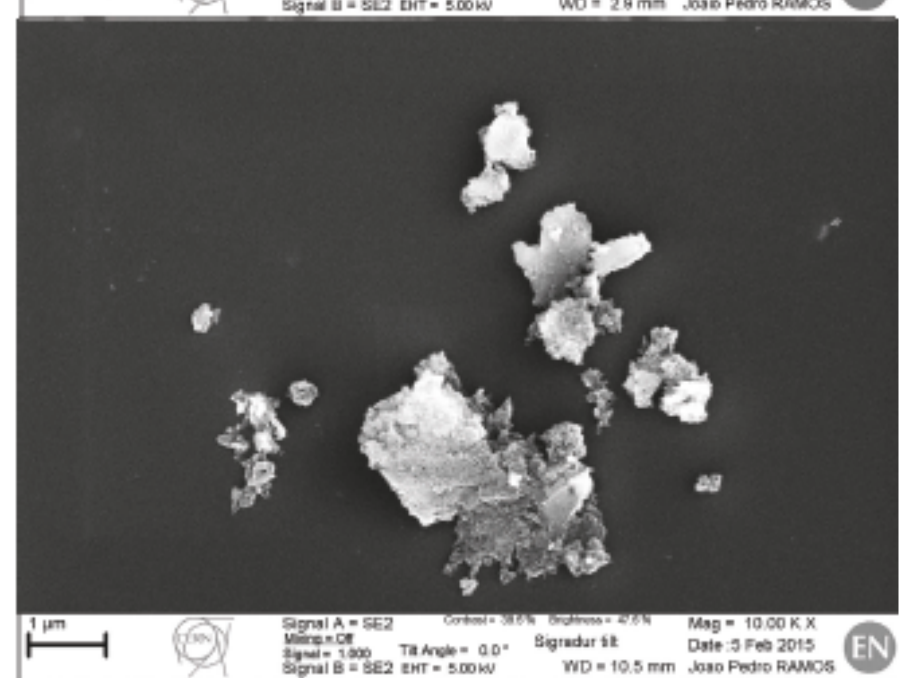
Surface ionisation efficiency

graphite



11 %

Sigradur G



18 %